PULSE DESCRIPTOR WORD STREAMING WITH THE R&S®SMW200A

The R&S®SMW200A vector signal generator can take on the role of a powerful and flexible signal generation source for the most realistic and agile radar scenarios in highly integrated radar scenario simulators. Equipped with the R&S®SMW-K503/-K504 options, the R&S®SMW200A can generate any state-of-the-art and future I/Q modulated radar signals from streamed pulse descriptor words (PDW). It supports a PDW execution rate of up to 12 megapulse descriptor words per second (MPDW/s).

R&S®SMW200A vector signal generator

Your task

Radar engineers often use software tools such as the R&S®Pulse Sequencer software to calculate radar scenarios. This is a convenient solution for research and development and during verification of radar equipment. Users can change parameters quickly and have a lot of flexibility when designing the radar scenario.

For operational tests, radar engineers often need to generate ultralong radar scenarios that contain demanding electronic warfare (EW) environments with high pulse density. Scenarios can originate from earlier simulations or live recordings. They are often stored as lists of pulse descriptor words (PDW) on a recorder. The PDWs contain the radar signal parameters for each pulse together with a timestamp that defines the pulse start time.

System level testing is often performed in a hardware-in-the-loop environment. The output of the device under test (DUT) is evaluated and influences its input signal, so scenarios need to be calculated in real time. This requires powerful simulation engines that calculate PDWs based on the DUT's output.

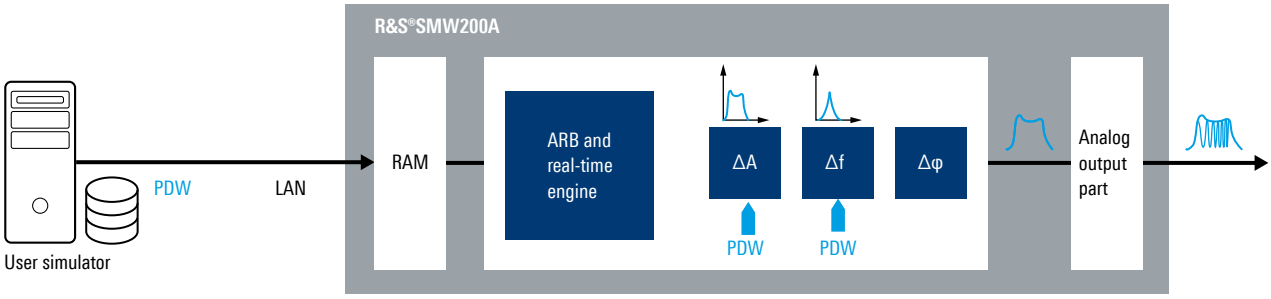
For operational tests and for system level testing, radar engineers need a RF signal source that can receive the streamed PDWs, e.g. over LAN, interpret them and generate the radar signal from the PDWs.

Rohde&Schwarz solution

The R&S®SMW200A takes on the role of an agile sgnal source that generates demanding EW environments within its baseband bandwidth of 2 GHz and with a RF frequency of up to 44 GHz. It generates I/Q modulated pulsed signals, agile signals with fast switching and classic pulsed signals from streamed PDWs. The R&S®SMW200A receives the streamed PDWs from the radar signal simulator via LAN. The powerful baseband hardware interprets the PDWs and generates the RF signal based on the pulse descriptions at the time defined in the PDWs. The R&S®SMW200A can execute and generate pulses from up to six parallel PDW streams with a maximum execution rate of up to 2 Mpulse/s or 2 MPDW/s per stream.

Synchronization with the DUT can be easily achieved using common reference signals (10 MHz or 1 GHz) and marker signals, such as pulse-, pre- and post-marker.

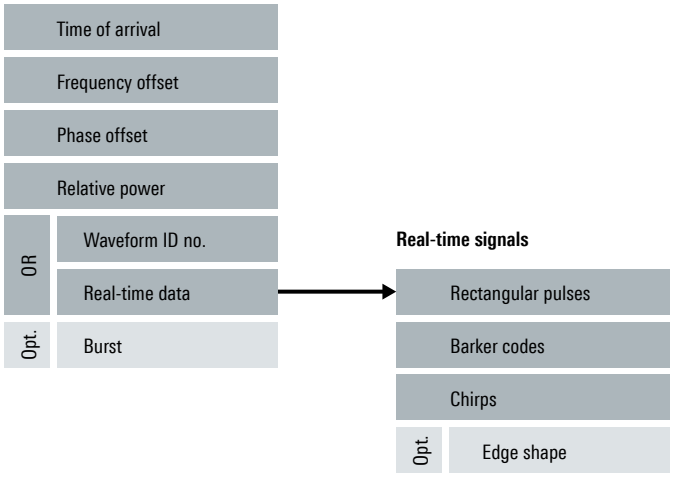
Concept of PDW streaming with the R&S®SMW200A



The Rohde & Schwarz PDW format

A single PDW representing one pulse has a fixed length and contains data with information such as time of arrival (ToA), frequency offset, amplitude offset, pulse duration and modulation parameters. This information can be used either to generate a classic pulse (real-time data) or an I/Q waveform segment (waveform ID number). An optional extension of the PDW format makes it possible to specify edge shapes and repetitive pulse bursts.

The Rohde & Schwarz PDW format



Streaming classic PDWs (real-time data)

For PDWs that only contain classic pulsed signals, users benefit from the real-time signal generation capability of the R&S®SMW200A wideband baseband hardware. Unmodulated pulses, Barker coded pulses, linear FM pulses (chirps) together with frequency offsets or amplitude offsets are generated in real time based on the parameters defined in the PDW. The pulse start time is defined by the ToA timestamp included in the PDW.

Streaming control PDWs

Control PDWs give the user direct control of the RF hardware of the R&S®SMW200A without stopping the stream. Control PDWs make it possible to change the absolute RF frequency (e.g. from X-band to C-band to simulate different radar bands) or RF level (e.g. from 0 dBm to –20 dBm to simulate emitters' different effective isotropic radiated powers, EIRP) of the instrument without the need for an extra remote command.

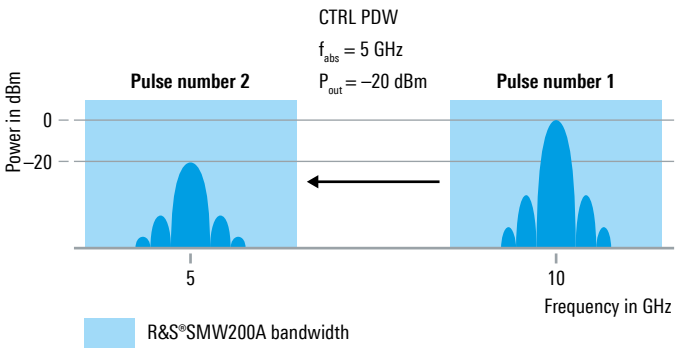
The user can utilize the full RF frequency range and dynamic range of the RF hardware and switch the RF frequency to cover different radar bands. By embedding these control commands in the stream, the start of the change can be exactly determined by a ToA timestamp. The signal can be changed in a predictable and stable manner. The command is executed after a very short muting period and PDWs can be processed again.

Key performance parameters for real-time signals

Minimum PRI for real-time signals per stream	0.5 µs
Minimum PRI for I/Q waveform segments per stream	1 µs
Maximum PDW execution rate per instrument with six streams	12 MPDW/s

Effect of a control PDW

Changing both frequency and amplitude of the RF path



Generating I/Q modulated signals

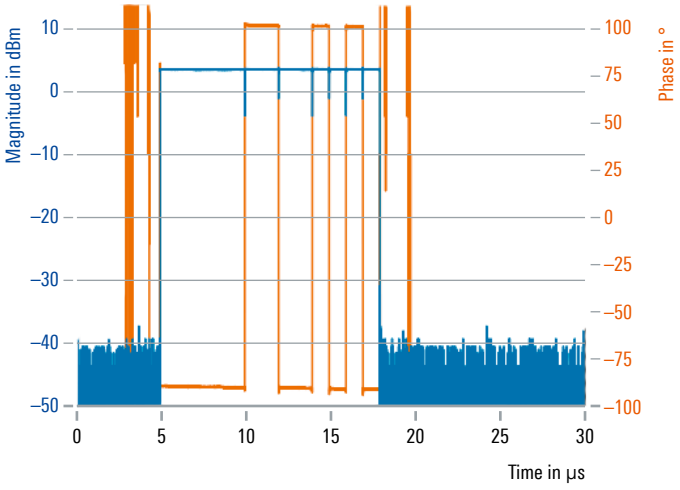
The R&S®SMW200A vector signal generator can also generate any I/Q modulated signal from streamed PDWs. The PDW can contain a reference to a predefined waveform segment that is prestored in the memory of the digital baseband. This solution enables the user to mix PDWs defining classic pulsed signals with state-of-the-art radar signals described by I and Q. The ToA information defines the start of signal generation. Frequency, amplitude and phase offsets are applied in real time as defined by the PDW.

Shaped pulse edges and bursts

As a unique feature, the pulse edge shape can be specified in the PDW without utilizing I/Q segments. Rectangular, linear or raised cosine shapes are available. These shapes allow realistic bandwidth limited testing of receivers without external filters. In order to create multiple identical pulses with a single PDW, the PDW format extension for pulse bursts allows specifying a PRI and a number of repetitions.

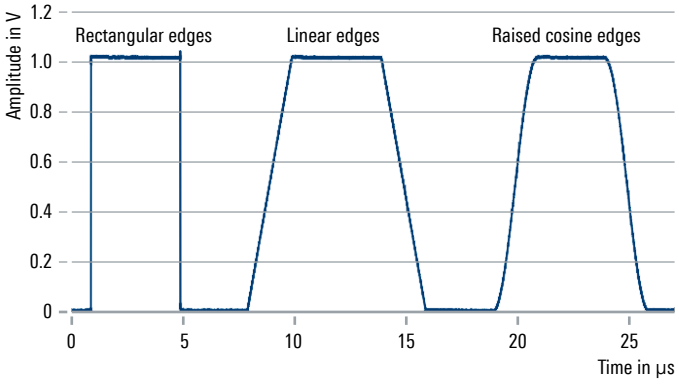
Modulated pulses

Modulated pulses with Barker code 13 can be generated in real time



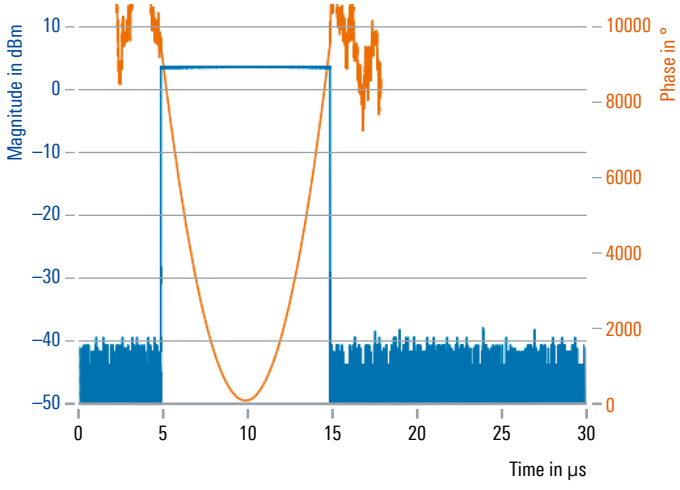
Shaped pulse edges

Rectangular pulse followed by pulses with linear and raised cosine edges



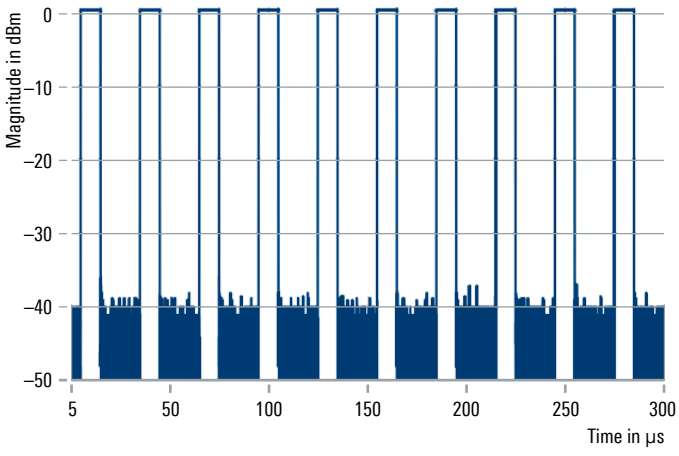
Modulated pulses

Modulated pulses with linear frequency modulation can be generated in real time



Pulse burst

Ten rectangular pulses generated with a single PDW



Pulse-on-pulse multiple emitter simulation

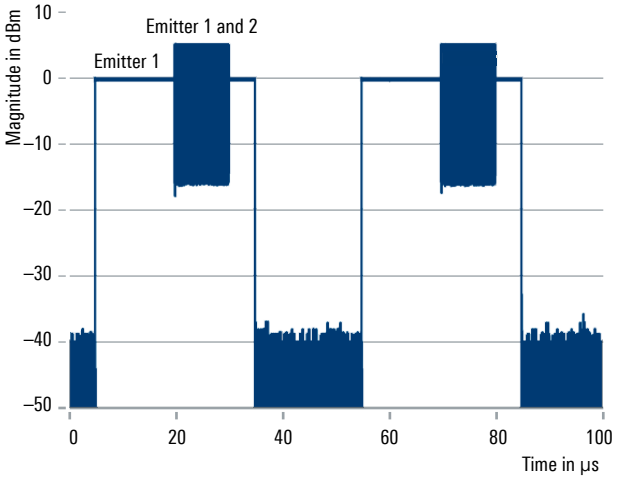
In order to create a demanding test environment, the signal generator must be able to simulate several emitters at once and needs to perform pulse-on-pulse simulation.

When equipped with two wideband baseband generators (R&S®SMW-B9), the R&S®SMW200A can accept two independent PDW streams. By installing two or four additional processing boards (R&S®SMW-B15), the number of simultaneous streams increases to six. The PDW streams assigned to a dedicated RF output are internally synchronously added. Either all PDW streams can be routed to one single RF output or, if two RF paths are installed, up to three streams can be assigned to each RF output.

With one R&S®SMW200A providing up to six streams (e.g. emitters), multichannel setups become compact, simpler and have a smaller footprint.

Pulse-on-pulse situation

Resulting from multiple simultaneous transmitting emitters



Integration into hardware-in-the-loop (HIL) setups

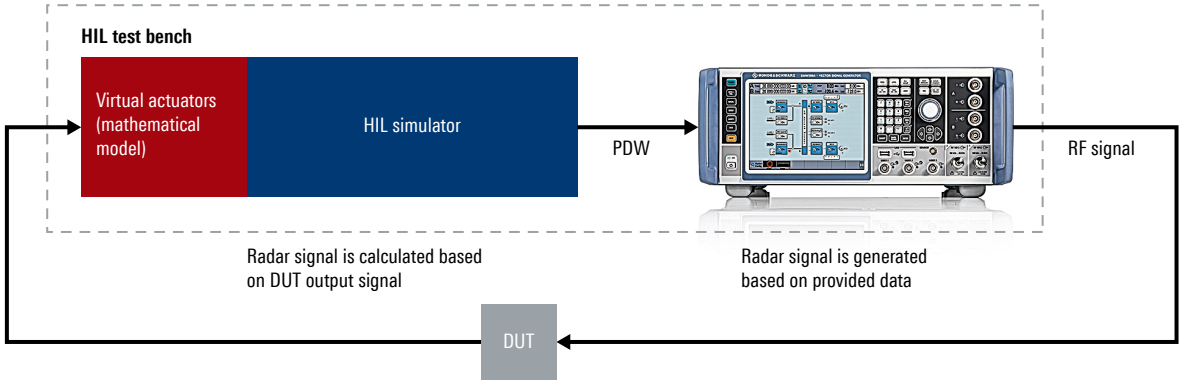
HIL simulation is a test method where a DUT is embedded in a simulator system that emulates the DUT's real environment. For receiver testing, the DUT is typically connected to a signal generator that is controlled by the simulator. The simulator evaluates the output data of the DUT based on its input signal coming from the signal generator and adjusts the generator according to the test parameters.

Requirements for a signal generator in a HIL setup are real-time capability, high update rate and low latency. With its ability to accept real-time PDW streams and the low delay from its Ethernet port to the RF output port, the R&S®SMW200A is ideally suited for integration into such a setup. In a HIL simulation, accurate synchronization between all devices is a must. The R&S®SMW200A provides multiple options for synchronization with the HIL simulator by supporting an external reference clock input, trigger inputs and user-defined marker outputs. Comprehensive PDW stream statistics are also available for easier debugging.

Benefits and key features

- Real-time radar signal generation for HIL tests
- PDW execution rate of up to 12 MPDW/s per instrument
- Multi-emitter PDW streaming with pulse-on-pulse in a single box
- Generation of any I/Q modulated waveforms
- Bandwidth-limited testing by means of shaped pulse edges
- Ultralong signal playtime with minimum memory requirements
- Two independent RF paths within a single box
- Outstanding signal quality

Hardware-in-the-loop test bench with the R&S®SMW200A



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Pulse descriptor word streaming with the R&S®SMW200A
Data without tolerance limits is not binding | Subject to change

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